BIOCHEMISTRY I Spring **2013**

(General medicine, Dental medicine)

The examination has two parts.

The computer test - the first part of the examination

The test consists of 25 questions and is solved on computers in the computer room of Department of Biochemistry (time limit 45 min) (specific personal number /UCO/ and key-word for IS MUNI is necessary for entrance to the test):
An essential knowledge ranging over all studied topics is required. Above all, the structural formulas of the cardinal compounds with biochemical significance, chemical equations of elemental reactions in major metabolic pathways (with particular formulas), and basic principles of metabolic control.
Only those students who gain 14 correct answers at a minimum will be permitted to sit for the oral examination.

The oral part of examination
Students select three questions and have about 30 minutes for the written preparation. They should summarize their answers as concisely and accurately as possible.
It is recommended to follow these items:
- to write a brief synopsis emphasizing the main ideas
- to draw metabolic pathways in structural formulas with a short comment
- where appropriate, to draw a picture (e.g. membranes, respiratory chain etc.)

A good and concise preparation reflects the students' knowledge and understanding the biochemistry and will be considered in the final classification.

List of questions for the oral examination

1. Structure of haemoglobin, structure-function relationships (the oxygen saturation curve, inducement of haemoglobin saturation and oxygen transport. Bohr effect.

2. Normal haemoglobin types in blood, haemoglobin concentration. Other forms (glycohaemoglobin, methaemoglobin, carboxyhaemoglobin) and abnormal haemoglobins.

3. Enzymes - structure and catalytic function, characteristics of biocatalysis. Enzyme-substrate interaction, examples of mechanisms of enzyme-catalyzed reactions. The term ″isoenzymes“.

4. Kinetics of enzyme-catalyzed monomolecular reactions: the term reaction rate, factors affecting the rates of enzyme-catalyzed reactions. The progress curves, the Michaelis-Menten plots (saturation curves), the K_m value and its significance.

5. The enzyme activity (the term, units of enzyme activity U and katals, catalytic concentration) and assays of enzymes (the conditions used in enzyme assays, the kinetics arranged by the substrate concentration, the kinetic and/or constant-time method).

6. Factors affecting catalytic activity of enzymes (the optimal conditions, activators and inhibitors, basal types of inhibitors, the distinguishing competitive from noncompetitive inhibition using saturation curves. The roles of metal ions in enzymatic catalysis (cofactors, metals as activators and inhibitors, examples of metalloenzymes).

7. Regulation of the catalytic activity of enzymes by covalent modification (namely conversions of proenzymes, reversible phosphorylations, activation of proteinkinases). Allosteric proteins and enzymes (cooperativity, allosteric activation and inhibition).

8. The roles of hydrogen and oxygen in the energy exchange of living systems (foodstuffs for chemotrophs, three stages in the extraction of energy from nutrients, reducing equivalents), production of ATP by oxidative phosphorylation and by phosphorylation on the substrate level. Energy status of a cell. Role of adenylate cyclase.

9. Pyridine nucleotide-dependent dehydrogenases (structures of coenzymes, function).

10. Flavoproteins (structures and function of the flavin prosthetic group, function of flavin dehydrogenases).

11. Cytochromes of the mitochondrial respiratory chain (the main structural features, the roles in mitochondrial complexes) and of monooxygenase hydroxylating systems (cytochrome P450).

12. Mitochondria (general structure, overview of the main roles in metabolism). Transporter systems in the inner mitochondrial membrane (transport and transporter types, examples).

13. The origin of reactive oxygen species, oxygen radicals detoxification (enzymes and natural antioxidants).

14. The mitochondrial respiratory chain (function, the main components of the mitochondrial complexes, the proton-motive force, the respiratory control).

15. Ubiquinone (structure, function) and iron-sulphur proteins (the term, function).

16. Energetics of the respiratory chain, oxidative phosphorylation (structure and function of the ATP synthase, coupling of phosphorylation to electron transport, respiratory control, uncouplers).

17. Peroxidation of lipids. Tocoferols and futher lipophilic antioxidants.

18. Naturally-occurring tensides (structural types, micelles, biomembranes, tensides in lipid digestion).

19. The citric acid cycle - localization, reactions of the cycle; the amphibolic role of the cycle (the final pathway for the oxidation of nutrients, and the pathways originating from the cycle).

20. The energetic yield and regulation of the citric acid cycle. The anaplerotic reactions (replenishing the intermediates of the cycle).

21. Transport of glucose into cells. Glucose transporters – types.

22. The glycolytic pathway - localization, the reactions of glycolysis, regulation of glycolysis.

23. The glycolysis under anaerobic conditions - the role of lactate dehydrogenase reaction, the Cori cycle; the LD isoenzymes.

24. The energetic yield of glycolysis under anaerobic and anaerobic conditions.

25. The oxidative decarboxylation of pyruvate and other 2-oxoacids (localization, the roles of particular coenzymes in the pyruvate and 2-oxoglutarate dehydrogenase complexes, energetics, significance).

26. Glycogen synthesis - localization, reactions, control mechanisms.

27. Glycogenolysis in the liver and skeletal muscle - the steps and control of glycogen degradation, inherited

disorders.

28. Gluconeogenesis (localization, substrates and the course of gluconeogenesis, regulation), relationship between glycolysis and glyconeogenesis.

29. The pentose phosphate pathway (localization, the sequence of reactions, physiological importance).

30. Synthesis of amino sugars and sialic acids, significance for the synthesis of glycoproteins and proteoglycans. Synthesis and metabolism of glucuronic acid (the uronic acid pathway).

31. Metabolism of fructose and galactose, defects.

32. Biosynthesis of fatty acids, control mechanisms;.

33. The oxidative breakdown of fatty acids (localization, the reaction sequence, energetic yield, control mechanism).

34. The transfer of long-chain fatty acyl-CoA into the mitochondria and the transfer of acetyl-CoA into the cytosol (control mechanisms).

35. Ketogenesis - localization, the pathway and the control of it; the utilization of ketone bodies. The circumstances causing ketoacidosis.

36. Desaturation of fatty acids. Polyunsaturated fatty acids (sources and interconversions, significance)

37. Eicosanoids (basic structural types, the initial steps of the synthesis, the basal features of their function, inhibitors of eicosanoid production as anti-inflammatory agents).

38. Biosynthesis of triacylglycerols, the main features os structure and synthesis of glycerophospholipids.

39. Degradation of triacylglycerols. Lipases-their function and types.

40. Biosynthesis of cholesterol (the most important reactions and stages, regulation), excretion of cholesterol and the cholesterol balance in the body.

41. Synthesis of bile acids - localization, main steps of the synthesis, secretion and elimination from the body.

42. Nutritionally essential amino acids. Biosynthesis of nonessential amino acids (Asp, Glu, Ser, Pro, Cys, Tyr).

43. Intracellular degradation of proteins (proteasoms, lyzosomes)

44. Deamination of amino acids and transamination (deamination types, reaction course, coenzymes, consequence of reactions in removal of amino groups from amino acids).

45. Detoxification of ammonia (the ureosynthetic cycle, glutamine, glutamate).

46. Glucogenic and ketogenic amino acids ("families" according to the resulting amphibolic intermediates, reversible interconversions of amino acids, essential amino acids).

47. Metabolism of dicarboxylic amino acids.

48. Metabolites and specialized products of proline, histidine, and tryptophan significant in metabolism.

49. Conversions of arginine, utilization of the guanidine part (biosynthesis of creatine, nitroxide formation).

50. Conversions of glycine and serine, the utilization in anabolic pathways (one-carbon units, aminolevulinate, purine, creatine, conjugation to aromatic acids).

51. Metabolism of sulphur-containing amino acids. Selenocysteine.

52. Glutathione - structure, functions (reducing effect, conjugations with GSH).

53. Catabolism of phenylalanine and tyrosine; metabolic disorders of their catabolism (phenylketonuria, tyrosinemia, alkaptonuria).

54. Hydroxylation of phenylalanine, tyrosine, and tryptophan (coenzyme, phenylketonuria, DOPA, serotonin).

55. Significance and the basic features of the branched-chain amino acids catabolism.

56. Decarboxylation of amino acids (coenzyme, some physiologically important reaction products and significance of them).

57. Biosynthesis of catecholamines.

58. Biosynthesis of creatine, function in muscles, conversion and excretion.

59. Biosynthesis of haem. Porphyrias.

60. The basic steps in purine and pyrimidine nucleotide biosynthesis (the compounds donating the nitrogen and carbon atoms of the heterocyclic rings) and the regulation.

61. Role of folate at the synthesis of purine and pyrimidine nucleotides, synthetic derivatives (drugs) affecting metabolism of folate (methotrexate, trimethoprim, sulphonamides)

62. DNA damage and repair.

63. Catabolism of purine and pyrimidine nucleotides and elimination of the end-products.

64. Species of RNA and the functions of them, processing of the primary transcripts generating the functional RNA types.

65. DNA replication in eukaryotes (topoisomerases and other factors involved in replication, particular steps, and polarity of replication).

66. RNA synthesis (RNA polymerases, process of transcription and transcription signals in eukaryotic cells).

67. Proteosynthesis (ribosomal proteosynthetic complex, formation of initiation complex, elongation and termination)

68. Posttranslational processing of proteins (various types of covalent modification), Golgi complex and glycosylation of proteins

69. Regulation of eukaryotic gene expression.

70. Membrane structure, the assembly and recycling of membranes. Specialized structures of plasma membrane – lipid rafts, caveols, tight junctions.

71. Transport across membranes (various types of passive and active transport mechanisms, characters of transporters and ionophores, examples).

72. Thiamin –sources and the physiological role of TDP (examples of reactions demanding TDP), consequences of deficiency.

73. Coenzymes of acyl transferases, transfer of acyls (coenzyme A and phosphopantetheine, lipoamide, carnitine).

74. Methylation and carboxylation - reaction sequences, enzymes and coenzymes, the roles in metabolism.

75. Folate and tetrahydrofolate (structures, relations to 4-aminobenzoate and action of sulfonamides); one-carbon units - sources, transfer and interconversions, the utilization).

76. L-Ascorbate - sources, utilization in biochemical redox reactions (examples).

77. Riboflavine- sources, utilization in metabolism, consequence of deficiency

78. Niacin - sources, utilization in metabolism, consequence of deficiency

79. Pyridoxin- sources, utilization in metabolism, consequence of deficiency

80. Biotin – sources of vitamin, function in metabolism

81. Vitamin B_{12} - sources of vitamin, function in metabolism, consequence of deficiency